Listing of Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (original) A hole inspection system for inspecting complex holes extending between an outer surface of a wall of a structure and an inner surface forming a cavity in the structure, each of the complex holes having an outer portion having a larger cross-sectional area adjacent the outer surface and a smaller cross-sectional area within the wall, and each of the complex holes having an inner portion extending between the smaller cross-sectional area and an inlet opening on the inner surface of the cavity, the hole inspection system comprising:

a light source emitting light over its length and adapted to be inserted in the cavity and provide light through the complex holes;

a multi-axes machine having a camera mounted thereon, the camera having a lens and being movable by the machine to inspection positions at which the lens is substantially centered over a respective complex hole; and

a control connected to the multi-axes machine and the camera and being operable to cause the multi-axes machine to move the camera to successive inspection positions, the control processing substantially only light intensity values representing light shining through a complex hole associated with a respective inspection position.

2. (original) The hole inspection system of claim 1 wherein the light source has an illuminated portion with a length substantially equal to a length of the cavity.

3. (original) The hole inspection system of claim 1 wherein the light source comprises a fiber optic light source.

4. (original) A method of inspecting a plurality of complex holes extending between an outer surface of a wall of a structure and an inner surface forming a cavity in the structure, each of the plurality of complex holes having an outer portion having a larger cross-sectional area adjacent the outer surface and a smaller cross-sectional area within the wall, and each of the plurality of complex holes having an inner portion extending between the smaller cross-sectional area and an inlet opening on the inner surface of the cavity, the method comprising:

illuminating the cavity with a light source emitting light over its length;

moving automatically a camera to an inspection position with respect to one of the plurality of complex holes at which the camera would receive light from the one of the plurality of complex holes if the one of the complex holes is properly formed;

determining automatically a maximum intensity value of the light received by the camera from the one of the plurality of complex holes;

comparing automatically the maximum intensity value to a threshold value;

creating automatically error data identifying the one of the plurality of complex holes in response to the maximum intensity value being less than the threshold value; and

iterating automatically the steps of moving, determining, comparing and creating for each of the plurality of complex holes.

5. (original) The method of claim 4 wherein at the inspection position a centerline of a lens of the camera is substantially collinear with a centerline of a respective complex hole.

6. (original) A method of inspecting complex holes extending between an outer surface of a wall of a structure and an inner surface forming a cavity in the structure, each of the complex holes having an outer portion with a larger cross-sectional area adjacent the outer surface and a smaller cross-sectional area within the wall, and each of the complex holes having an inner portion extending between the smaller cross-sectional area and an inlet opening on the inner surface of the cavity, the method comprising:

illuminating the cavity with a light source emitting light over its length;

moving automatically a camera to an inspection position with respect to each of the complex holes at which the camera would receive light from a respective complex hole if the respective complex hole is properly formed;

determining automatically a maximum intensity value of the light received by the camera from each of the complex holes;

comparing automatically the maximum intensity value to a threshold value; and

creating automatically error data identifying one of the complex holes in response to a respective maximum intensity value being less than the threshold value.

7. (original) The method of claim 6 wherein determining automatically a maximum intensity value further comprises:

storing substantially only light intensity values representing light shining through a complex hole associated with the respective inspection position; and

identifying the maximum intensity value as a largest of the light intensity values.

8. (currently amended) The method of claim 7 further ~~comprises~~ comprising detecting light intensity values within a field of interest representing the light shining through the respective complex hole associated with the inspection position

9. (currently amended) The method of claim [[7]] 8 wherein the inspection position comprises a camera location where the larger cross-sectional area of the one of the complex holes is substantially centrally located in [[a]] the field of interest.

10. (currently amended) The method of claim 7 further ~~comprises~~ comprising creating a histogram from the light intensity values in order to identify the maximum intensity value.

11. (original) The method of claim 6 wherein the inspection position comprises a camera location where the larger cross-sectional area of the one of the complex holes is substantially centrally located in a field of view of the camera.

12. (currently amended) The method of claim 6 wherein [[at]] the inspection position comprises a camera location where a centerline of a lens of the camera is substantially collinear with a centerline of the respective complex hole.

13. (original) A method of calibrating a light inspection system for inspecting a plurality of complex holes extending between an outer surface of a wall of a structure and an inner surface forming a cavity in the structure, each of the plurality of complex holes having an outer portion having a larger cross-sectional area adjacent the outer surface and a smaller cross-sectional area within the wall, and each of the plurality of complex holes having an inner portion extending between the smaller cross-sectional area and an inlet opening on the inner surface of the cavity, the method comprising:

moving automatically a camera to an inspection position with respect to one of the plurality of complex holes at which the larger cross-sectional area of the one of the complex holes is substantially centrally located in a field of view of the camera;

determining automatically, with the cavity not being illuminated, a maximum intensity value of the light received by the camera; and

determining a threshold intensity value larger than the maximum intensity value.

14. (original) The method of claim 13 wherein determining automatically a maximum intensity value further comprises:

storing substantially only light intensity values representing light being substantially directly over the one of the plurality of complex holes; and

identifying the maximum intensity value as a largest of the light intensity values.

15. (currently amended) The method of claim 14 further ~~comprises~~ comprising, prior to storing, detecting light intensity values within a field of interest representing the light being substantially directly over the one of the plurality of complex holes.

16. (currently amended) The method of claim 14 further ~~comprises~~ comprising creating a histogram from the light intensity values in order to identify the maximum intensity value.

17. (original) The method of claim 13 further comprising:

iterating automatically the steps of moving and determining automatically a maximum intensity value for each of the plurality of complex holes;

identifying a largest maximum intensity value; and

determining the threshold intensity value greater than the largest maximum intensity value.

18. (original) A method of calibrating a light inspection system for inspecting complex holes extending between an outer surface of a wall of a structure and an inner surface forming a cavity in the structure, each of the complex holes having an outer portion with a larger cross-sectional area adjacent the outer surface and a smaller cross-sectional area within the wall, and each of the complex holes having an inner portion extending between the smaller cross-sectional area and an inlet opening on the inner surface of the cavity, the method comprising:

moving automatically a camera to an inspection position with respect to one of the complex holes at which the larger cross-sectional area of the one of the complex holes is aligned with a region of interest within a field of view of the camera;

determining automatically, with the cavity not being illuminated, a maximum intensity value of light within the region of interest from the one of the complex holes; and

determining automatically a threshold value greater than the maximum intensity value.

19. (original) The method of claim 17 wherein determining automatically a maximum intensity value further comprises:

storing substantially only light intensity values received from the camera within a field of interest;

creating a histogram from the light intensity values in order to identify the maximum intensity value; and

identifying the maximum intensity value as a largest of the light intensity values.

20. (original) The method of claim 19 further comprising iterating the steps of moving and determining automatically a maximum intensity value for all of the complex holes.

21. (original) A method of calibrating a light inspection system for inspecting complex holes extending between an outer surface of a wall of a structure and an inner surface forming a cavity in the structure, each of the complex holes having an outer portion with a larger cross-sectional area adjacent the outer surface and a smaller cross-sectional area within the wall, and each of the complex holes having an inner portion extending between the smaller cross-sectional area and an inlet opening on the inner surface of the cavity, the method comprising:

moving automatically a camera to inspection positions with respect to a plurality of the complex holes at which the larger cross-sectional area of a respective complex hole is aligned with a region of interest within a field of view of the camera;

determining automatically, with the cavity not being illuminated, a maximum intensity value of the light within the field of interest for each of the plurality of the complex holes;

illuminating the cavity with a light source;

moving automatically a camera to the inspection positions with respect to the plurality of the complex holes;

determining automatically a minimum intensity value of the light within the field of interest for each of the plurality of the complex holes; and

determining automatically a threshold value greater than the maximum intensity value.

22. (original) The method of claim 21 wherein determining automatically a threshold value further comprises:

determining an average value of the maximum intensity value and the minimum intensity value; and

summing the average value and the maximum intensity value to provide the threshold value.